GRADE 12
DIPLOMA EXAMINATION

Chemistry 30

June 1987

Alberta
EDUCATION

CHEMISTRY 30 MULTIPLE CHOICE KEY

1	A	29	D
2	B	30	D
3	C	31	D
4	B	32	C
5	C	33	B
6	B	34	B
7	C	35	C
8	D	36	A
9	B	37	B
10	C	38	C
11	D	39	C
12	B	40	B
13	C	41	B
14	A	42	A
15	A	43	D
16	D	44	C
17	A	45	A
18	C	46	B
19	D	47	C
20	A	48	B
21	A	49	D
22	B	50	A
23	C	51	B
24	C	52	D
25	B	53	B
26	A	54	A
27	D	55	A
28	C	56	D

GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A chemistry data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example	**Answer Sheet**			
This examination is for the subject area of	A	B	C	D
A. Chemistry	●	②	③	④
B. Biology				
C. Physics				
D. Mathematics				

If you wish to change an answer, please erase your first mark completely.

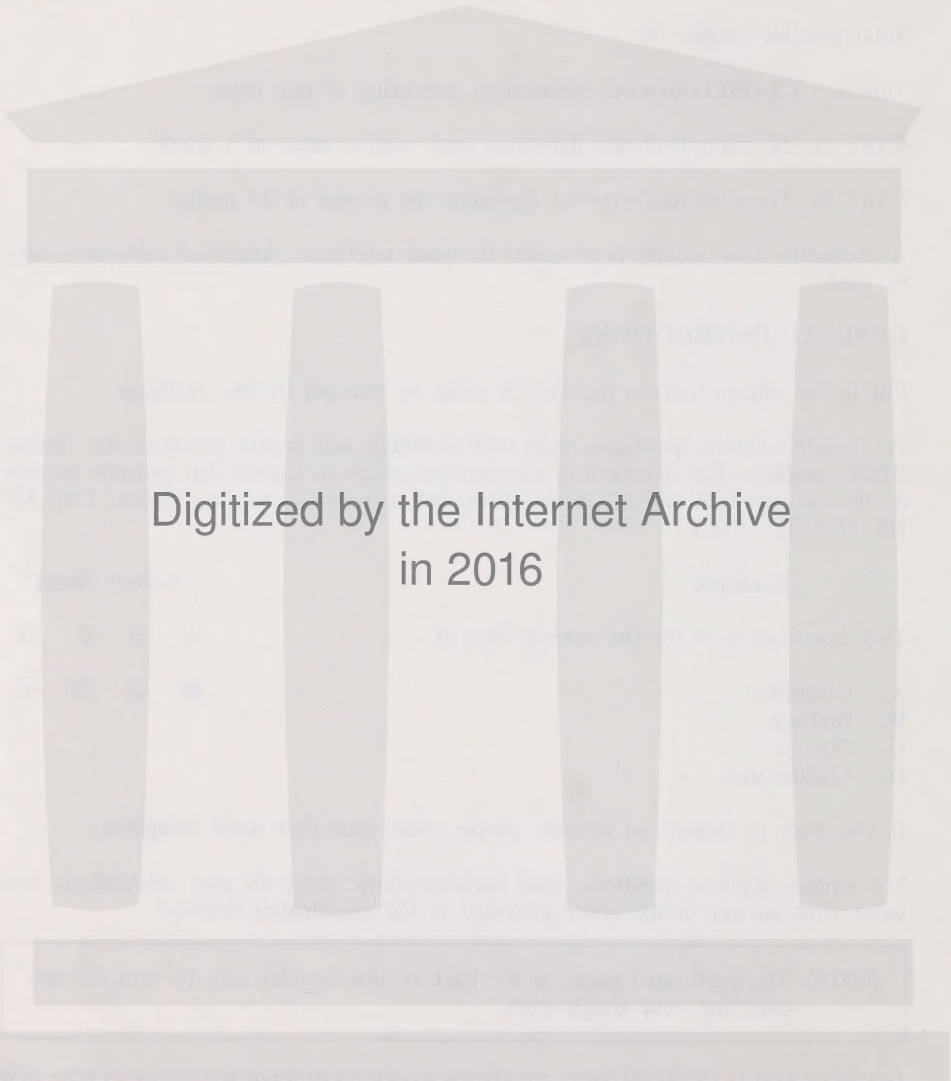
For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JUNE 1987



PART A

INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

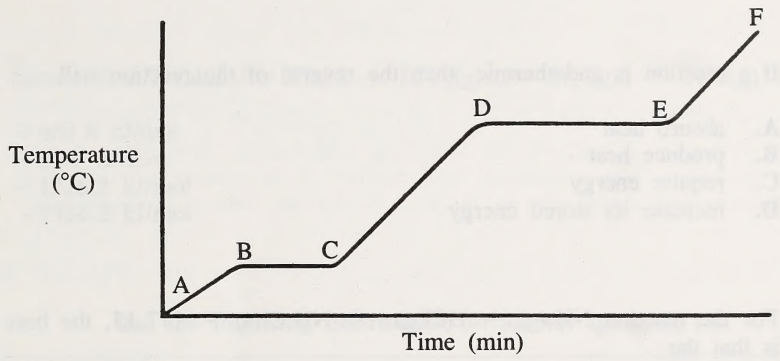
NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER

Use the following information to answer question 1.

A student uniformly heated a solid sample for a period of time and the following graph was obtained using the data collected.



1. The section of the graph from B to C would best be interpreted as representing a gain in

   A. E_p and a phase change
   B. E_k and a phase change
   C. E_p and a loss in E_k
   D. E_k and a loss in E_p

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2. When a student warms a sample of ice from $-10.0°C$ to $-6.0°C$, the best prediction is that the

   A. kinetic energy of the molecules decreases
   B. kinetic energy of the molecules increases
   C. potential energy of the molecules increases
   D. potential and kinetic energies of the molecules increase

3. Consider the equation $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g) + 94$ kJ. The heat of formation of $NH_3(g)$ under these conditions would be

A. +94 kJ/mol
B. +47 kJ/mol
C. −47 kJ/mol
D. −94 kJ/mol

4. If a reaction is endothermic, then the reverse of the reaction will

A. absorb heat
B. produce heat
C. require energy
D. increase its stored energy

5. For the reaction $NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s) + 177$ kJ, the best prediction is that the

A. value for ΔH is +177 kJ
B. reaction uses energy from the surroundings
C. reactants contain more energy than the product
D. product contains more energy than the reactants

6. The change that should be predicted to involve the least amount of energy per mole of reactant is

A. ${}^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n$

B. $C_{25}H_{52}(l) \longrightarrow C_{25}H_{52}(s)$

C. $CuSO_4(s) \longrightarrow Cu(s) + \frac{1}{8}S_8(s) + 2O_2(g)$

D. $C_2H_6(g) + \frac{7}{2}O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(g)$

7. When a student applies sufficient heat to boil water under normal conditions, it will not form hydrogen gas and oxygen gas. The best interpretation of this observation is that

A. hydrogen bonding in water is relatively large
B. the heat applied must not have exceeded 40.8 kJ/mol
C. bonding between water molecules is weaker than bonding between atoms within water molecules
D. the energy required to boil water must be greater than the energy released when water forms from elements

8. For the reaction $H_2O(g) + C(s) + \text{heat} \longrightarrow CO(g) + H_2(g)$, it is correct to state that

A. the reaction has a negative ΔH value
B. heat is released to the reaction vessel
C. the products are more stable than the reactants
D. the products have a greater heat content than the reactants

9. The calculated ΔH value for $2Fe(s) + 3CO_2(g) \longrightarrow Fe_2O_3(s) + 3CO(g)$ is

A. +689.8 kJ/mol
B. +26.8 kJ/mol
C. −1326.2 kJ/mol
D. −2334.2 kJ/mol

Use the following information to answer question 10.

The following is data collected from an experiment to determine the molar heat of combustion of butter fat, $C_{15}H_{26}O_6(s)$.

Mass of water in calorimeter	425.0 g
Initial temperature of water	17.8°C
Final temperature of water	49.5°C
Mass of butter fat burned	2.15 g

10. The heat of combustion of butter fat calculated from the data is

A. -5.64×10^1 kJ/mol
B. -4.46×10^3 kJ/mol
C. -7.94×10^3 kJ/mol
D. -1.24×10^4 kJ/mol

11. For the compounds listed, which one should students predict would require the most energy per mole to decompose into its elements?

A. $NO(g)$
B. $NH_3(g)$
C. $NO_2(g)$
D. $C_2H_6(g)$

Use the following information to answer question 12.

A student determined the following information about three different reactions. Reaction A is exothermic and reaction B is endothermic. Reaction C can be expressed as the sum of reaction B plus the reverse of reaction A.

12. The student could best predict that reaction C has a heat of reaction that

A. is exothermic
B. is endothermic
C. is very close to zero
D. cannot be predicted from the above data

Use the following information to answer question 13.

The following predicted data are for a hypothetical element A and its reaction with oxygen.

$$A + \tfrac{1}{2}O_2 \longrightarrow AO \qquad \Delta H = +90.4 \text{ kJ}$$

$$A + O_2 \longrightarrow AO_2 \qquad \Delta H = +33.8 \text{ kJ}$$

13. The predicted energy per mole of AO_2 formed from the reaction between AO and oxygen would be

A. +248 kJ
B. +124 kJ
C. −56.6 kJ
D. −113 kJ

Use the following information to answer question 14.

The following data were recorded in a student's notebook:

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ $\quad \Delta H = -285.9$ kJ

$2Na(s) + \frac{1}{2}O_2(g) \longrightarrow Na_2O(s)$ $\quad \Delta H = -417.0$ kJ

$Na(s) + \frac{1}{2}O_2(g) + \frac{1}{2}H_2(g) \longrightarrow NaOH(aq)$ $\quad \Delta H = -470.0$ kJ

14. The student's calculated value for the heat of reaction for $Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$ should be

A. −237.1 kJ
B. −118.6 kJ
C. +118.6 kJ
D. +237.1 kJ

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15. A student determined experimentally that 2.06 kJ of heat energy were released when 0.635 g of copper reacted with excess chlorine. The enthalpy of formation of copper (II) chloride from this data would be

A. −206 kJ/mol
B. −1.09 kJ/mol
C. +2.71 kJ/mol
D. +165 kJ/mol

16. A student places a 19.65 g sample of molten gold, at its melting temperature, into a calorimeter containing 500 g of water. The temperature of the water increases by 10.0°C as the gold solidifies. Assuming that the temperature of the gold does not change, the student's calculated value for the molar heat of solidification of gold should be

A. −21.0 J/mol
B. −210 J/mol
C. −21.0 kJ/mol
D. −210 kJ/mol

17. A new sugar was synthesized for use in space travel. Its molar mass is 2.50×10^2 g/mol. When 1.00 g of the sugar was burned in a calorimeter, the temperature of 1.00×10^2 g of water increased by 30.6°C. The molar heat of combustion for this new sugar would be

A. -3.21×10^3 kJ/mol
B. -2.31×10^3 kJ/mol
C. -32.1 kJ/mol
D. -12.8 kJ/mol

18. In an average year, an 80 m^2 mobile home uses 2.75×10^8 kJ of heat. The number of moles of methane (assume gaseous products) needed to heat this mobile home for one year would be

A. 2.20×10^{11} mol
B. 4.91×10^5 mol
C. 3.43×10^5 mol
D. 2.89×10^5 mol

19. Lime juice, vinegar, and sour milk all

A. contain no $OH^-(aq)$
B. turn red litmus blue
C. have a pH greater than 7
D. contain an excess of $H_3O^+(aq)$

Use the following information to answer question 20.

A student compiled the following data about the behavior of a solution of oxalic acid:

I turns red when methyl red indicator is added
II forms $H_3O^+(aq)$ ions in solution
III reacts with an aqueous solution of NH_3
IV has a $[H_3O^+(aq)]$ greater than 10^{-7} mol/L

20. Which statement OPERATIONALLY defines the solution as acidic?

A. I
B. II
C. III
D. IV

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21. Which of the following is an acid-base reaction?

A. $HOCl(aq) + Na_3PO_4(aq) \longrightarrow NaOCl(aq) + Na_2HPO_4(aq)$

B. $FeCl_2(aq) + NaOH(aq) \longrightarrow Fe(OH)_2(s) + NaCl(aq)$

C. $2HNO_3(aq) + Mg(s) \longrightarrow Mg(NO_3)_2(aq) + H_2(g)$

D. $HCl(aq) + AgBr(s) \longrightarrow AgCl(s) + HBr(aq)$

Use the following information to answer question 22.

The following solutions are made available to a student.

I $CH_3COOH(aq)$

II $CH_3CH_2OH(aq)$

III $NH_3(aq)$

22. Which solution(s) could the student use to neutralize HCl(aq)?

A. II only
B. III only
C. I and II
D. I, II, and III

Use the following information to answer question 23.

Four beakers labelled W, X, Y, and Z contain equal volumes of 0.10 mol/L solutions of either monoprotic strong acids or monobasic strong bases. The following observations were made:

10.0 mL of W added to 10.0 mL of X yields a neutral solution
10.0 mL of Y added to 10.0 mL of Z yields a neutral solution
10.0 mL of X added to 10.0 mL of Y yields an acidic solution

23. The student should predict that the contents of the beakers W, X, Y, and Z respectively are

A. acid, acid, base, base
B. base, base, acid, acid
C. base, acid, acid, base
D. acid, base, base, acid

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24. The change that is typical of a base as defined by Brønsted-Lowry is that

A. $NH_4^+(aq)$ becomes $NH_3(aq)$

B. $H_2PO_4^-(aq)$ becomes $HPO_4^{2-}(aq)$

C. $HCOO^-(aq)$ becomes $HCOOH(aq)$

D. phenol red indicator changes from yellow to red

25. Given the appropriate conditions, which of the following statements is true?

A. $Na^+(aq)$ can act as an acid.
B. $HSO_4^-(aq)$ can act as a base.
C. $HClO_4(aq)$ can act as a base.
D. $SO_4^{2-}(aq)$ can act as an acid.

26. In the equation $H_2SO_4(aq) + CH_3COO^-(aq) \rightleftharpoons CH_3COOH(aq) + HSO_4^-(aq)$, the Brønsted-Lowry bases are

A. $CH_3COO^-(aq)$ and $HSO_4^-(aq)$

B. $CH_3COOH(aq)$ and $HSO_4^-(aq)$

C. $H_2SO_4(aq)$ and $CH_3COOH(aq)$

D. $CH_3COOH(aq)$ and $CH_3COO^-(aq)$

27. A strong acid, HX, is written in the ionic form in equations because the

A. degree of dissociation is very small
B. interaction between HX and water is relatively small
C. bond strengths between H^+ and X^- are relatively large
D. force of attraction between H^+ and X^- is very weak

28. A student should predict that in the reaction $HMo(aq) + SO_3^{2-}(aq) \rightleftharpoons Mo^-(aq) + HSO_3^-(aq)$, adding HCl(aq) to the system would cause the color of the solution to change from

A. orange to yellow
B. red to orange
C. yellow to red
D. red to yellow

29. Bases are substances that have

A. small $[H_3O^+(aq)]$ and small pH
B. small $[OH^-(aq)]$ and large pH
C. large $[OH^-(aq)]$ and small pH
D. large $[OH^-(aq)]$ and large pH

30. A student has an unknown solution which is 0.10 mol/L. The indicators orange IV and bromocresol green were both yellow in the solution. The unknown solution could be

A. HNO_3
B. LiOH
C. $NaHCO_3$
D. CH_3COOH

31. A student has prepared a solution in which the $[H_3O^+(aq)]$ is 1.0×10^{-3} mol/L. The student should predict that in this solution

A. methyl orange would be yellow
B. phenolphthalein would be pink
C. alizarin yellow would be red
D. litmus would be red

32. A 0.1 mol/L C_6H_5COOH solution reacts with a 0.1 mol/L NaOH solution. The net ionic equation that describes this reaction is

A. $H_3O^+(aq) + OH^-(aq) \rightleftharpoons H_2O(l)$

B. $H_3O^+(aq) + NaOH^-(aq) \rightleftharpoons H_2O(l) + Na^+(aq)$

C. $C_6H_5COOH(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + C_6H_5COO^-(aq)$

D. $C_6H_5COOH(aq) + NaOH(aq) \rightleftharpoons H_2O(l) + C_6H_5COO^-(aq) + Na^+(aq)$

33. The reaction that should be predicted to favor reactants at equilibrium is

A. $H_2SO_3(aq) + SO_3^{-2}(aq) \rightleftharpoons 2HSO_3^-(aq)$

B. $NH_4^+(aq) + F^-(aq) \rightleftharpoons HF(aq) + NH_3(aq)$

C. $HNO_2(aq) + NH_3(aq) \rightleftharpoons NH_4^+(aq) + NO_2^-(aq)$

D. $C_6H_5COOH(aq) + CH_3COO^-(aq) \rightleftharpoons CH_3COOH(aq) + C_6H_5COO^-(aq)$

34. If a student adds sodium hydroxide to a solution of hydrofluoric acid, the prediction should be that the

A. $[H_3O^+(aq)]$ will increase
B. $[F^-(aq)]$ will increase
C. [HF(aq)] will increase
D. pH will decrease

35. If 10.0 g of NaOH(s) is added to water to make 1.0 L of solution, the $[H_3O^+(aq)]$ will be

A. 2.50×10^{-15} mol/L
B. 1.00×10^{-14} mol/L
C. 4.00×10^{-14} mol/L
D. 2.50×10^{-1} mol/L

Use the following information to answer question 36.

The following data were collected during the titration of NaOH(aq) with HCl(aq).			
Volume of 0.100 mol/L HCl(aq) Used		Volume of NaOH(aq) Used	
Initial Reading	Final Reading	Initial Reading	Final Reading
10.05 mL	20.00 mL	8.02 mL	16.01 mL

36. The calculated concentration of the sodium hydroxide would be

A. 0.125 mol/L
B. 0.800 mol/L
C. 1.25 mol/L
D. 8.00 mol/L

37. A student has assumed that stomach acid has a pH of 1.00. What mass of sodium hydrogen carbonate should be predicted to just neutralize 50.0 mL of gastric juice?

A. 0.31 g
B. 0.42 g
C. 3.1 g
D. 4.2 g

38. The species most likely to undergo oxidation is

A. $Li^+(aq)$
B. $H^+(aq)$
C. $Ag(s)$
D. $F_2(g)$

39. The oxidizing agent in the equation

$3Mn(s) + 2Cr^{3+}(aq) \longrightarrow 3Mn^{2+}(aq) + 2Cr(s)$ is

A. $Cr(s)$
B. $Mn(s)$
C. $Cr^{3+}(aq)$
D. $Mn^{2+}(aq)$

40. A student should predict that adding $Cl_2(aq)$ to a test tube containing NaI(aq) and a non-polar molecular solvent would result in a purple colored layer because

A. $I^-(aq)$ ions are purple in color
B. $Cl_2(aq)$ oxidizes the $I^-(aq)$ ions
C. $Cl_2(aq)$ reduction potential is positive
D. $I^-(aq)$ is the stronger oxidizing agent

41. For the reaction represented by the equation

$2Zn(s) + O_2(g) + 2H_2O(l) \longrightarrow 2Zn^{2+}(aq) + 4OH^-(aq)$, the

A. $Zn(s)$ is being reduced
B. $Zn(s)$ is the reducing agent
C. $Zn^{2+}(aq)$ is gaining electrons
D. $O_2(g)$ and $H_2O(l)$ are being oxidized

42. In an oxidation-reduction reaction, $PO_4^{3-}(s)$ is changed to $P_2O_3(s)$. The change in oxidation number for each phosphorus atom is

A. 2
B. 3
C. 4
D. 5

43. If you are given a chemical equation in which the oxidation numbers of the substances do not change, it should be concluded that

A. the equation is balanced
B. no reaction has taken place
C. the number of electrons lost equals the number gained
D. the reaction is not an example of oxidation-reduction

44. When the equation
$C_2H_5OH(l) + Cr_2O_7^{2-}(aq) + H^+(aq) \longrightarrow CH_3CHO(l) + Cr^{3+}(aq) + H_2O(l)$
is balanced, the coefficient for water is

A. 3
B. 6
C. 7
D. 10

Use the following information to answer questions 45 to 47.

A student designed a redox titration experiment and wrote the following balanced equation for the reaction.

$MnO_4^-(aq) + 8H^+(aq) + 5Fe^{2+}(aq) \longrightarrow Mn^{2+}(aq) + 4H_2O(l) + 5Fe^{3+}(aq)$

45. The student should predict the oxidizing agent to be

A. $MnO_4^-(aq)$
B. $Fe^{2+}(aq)$
C. $Mn^{2+}(aq)$
D. $Fe^{3+}(aq)$

46. How many moles of $MnO_4^-(aq)$ should be predicted to react with 1.0×10^{-1} mol of $Fe^{2+}(aq)$?

A. 1.0×10^{-2} mol
B. 2.0×10^{-2} mol
C. 2.5×10^{-2} mol
D. 5.0×10^{-2} mol

47. The predicted number of electrons exchanged per $MnO_4^-(aq)$ should be

A. 1
B. 2
C. 5
D. 8

Use the following information to answer question 48.

During an experiment using four unknown metals and their aqueous ions, students recorded their data in the following form.

Metal \ Ion	W^+	X^+	Y^+	Z^+
W	NR	✓	✓	NR
X	NR	NR	NR	NR
Y	NR	✓	NR	NR
Z	✓	✓	✓	NR

✓ = reaction
NR = no reaction

48. The students' arrangement of ions from the strongest oxidizing agent to the weakest oxidizing agent should be

A. W^+, Y^+, X^+, Z^+
B. X^+, Y^+, W^+, Z^+
C. Z^+, W^+, Y^+, X^+
D. Z^+, X^+, Y^+, W^+

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49. The half reaction and its assigned reduction potential for the standard reference half-cell is

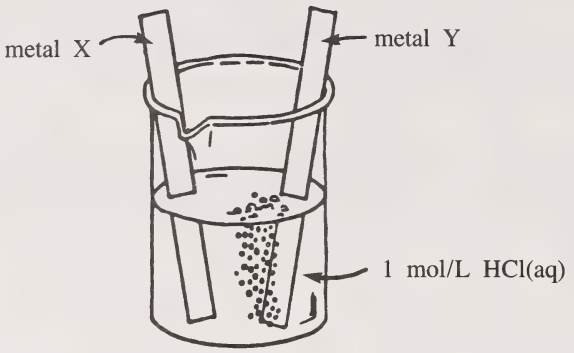
A. $2H_2O(l) + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$ $\quad E^\circ = -0.42$ V

B. $H_2O(l) \longrightarrow 2e^- + \frac{1}{2}O_2(g) + 2H^+(aq)$ $\quad E^\circ = -0.82$ V

C. $H_2(g) \longrightarrow 2H^+(aq) + 2e^-$ $\quad E^\circ = 0.00$ V

D. $2H^+(aq) + 2e^- \longrightarrow H_2(g)$ $\quad E^\circ = 0.00$ V

Use the following information to answer question 50.



50. Using your observations, metal Y could NOT be

A. Ag(s)
B. Cr(s)
C. Pb(s)
D. Zn(s)

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51. A student constructed a cell using aluminum metal in aqueous aluminum chloride and nickel metal in aqueous nickel (II) chloride, and then predicted the E° value. The predicted E° value should be

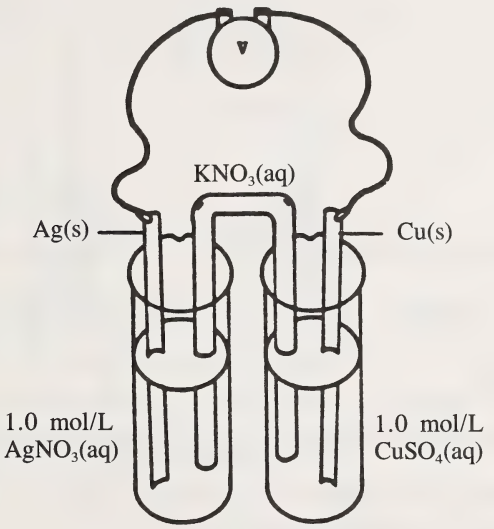
A. +1.89 V
B. +1.43 V
C. −1.43 V
D. −1.89 V

52. A student is assigned the task of clearing the laboratory bench. Which solution should the student not store in a nickel metal container?

A. NaCl(aq)
B. $CrCl_3$(aq)
C. $NiCl_2$(aq)
D. $SnCl_2$(aq)

Use the following information to answer question 53.

An electrochemical cell was assembled in the following manner.

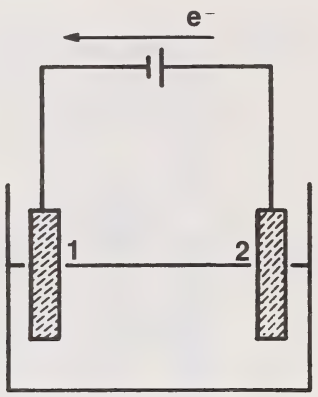


53. In the cell, electrical energy is generated by the

A. oxidation of Cu(s) and reduction of $NO_3^-(aq)$
B. oxidation of Cu(s) and reduction of $Ag^+(aq)$
C. oxidation of Ag(s) and reduction of $Cu^{2+}(aq)$
D. oxidation of Ag(s) and reduction of $SO_4^{2-}(aq)$

Use the following information to answer question 54.

The following diagram represents an electrolytic cell.



54. If there is molten NaCl in the cell, then students should predict that

A. $Cl^-(l)$ ions will migrate to electrode 2
B. $Cl^-(l)$ ions will migrate to electrode 1
C. $Na^+(l)$ ions will migrate to electrode 2
D. $Na^+(l)$ ions will migrate to electrodes 1 and 2

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55. In an electrolytic cell, the anode is the electrode where

A. oxidation occurs
B. cations are attracted
C. the oxidizing agent reacts
D. the salt bridge is attached

56. What occurs when metallic sodium is produced by the electrolysis of molten sodium chloride?

A. Sodium ions are oxidized.
B. Sodium ions lose electrons.
C. Chlorine gas escapes at the cathode.
D. Sodium metal collects at the cathode.

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

FOR
EPARTMENT
USE ONLY

Use the following information to answer question 1.

The following data refer to the compound acetone.

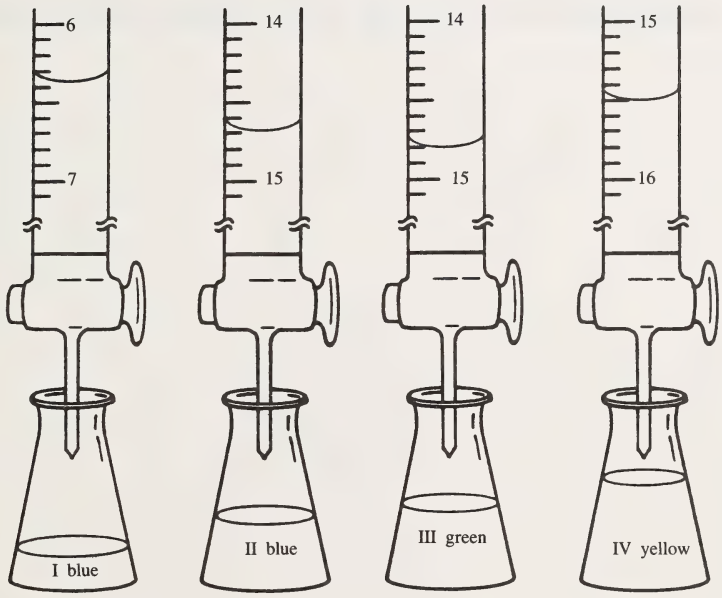
Formula	CH_3COCH_3
Specific heat of the liquid	2.63 J/g°C
Specific heat of the vapor	1.57 J/g°C
Melting point	−95.4°C
Boiling point	56.2°C
Molar heat of fusion	4.70 kJ/mol
Molar heat of vaporization	32.0 kJ/mol

(5 marks)

1. Calculate the amount of heat energy required to change 17.4 g of acetone from −50.0°C to 100.0°C.

Use the following information to answer question 2.

A student titrated 20.0 mL of NaOH(aq) containing bromothymol blue with 0.250 mol/L HNO_3(aq). The flask in step I contains only the base and the indicator. Steps II, III, and IV show resulting colors when progressive volumes of acid are added.



2. Use the resulting data to determine the concentration of the aqueous sodium hydroxide. **(4 marks)**

FOR DEPARTMENT USE ONLY

Use the following information to answer question 3.

A student used $Fe^{2+}(aq)$ to standardize a solution of $K_2Cr_2O_7$. The data for one trial of the titration were recorded as follows.

Volume of 0.300 mol/L $Fe^{2+}(aq)$	25.0 mL
Final buret reading $K_2Cr_2O_7(aq)$	37.2 mL
Initial buret reading $K_2Cr_2O_7(aq)$	21.7 mL

(5 marks)

3. Calculate the concentration of the $K_2Cr_2O_7$ solution used by the student.

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

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M1 M2 M3 M4

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